Investing Amid Turmoil: Diversification Opportunities in Islamic Stock Indices, Bitcoin, Gold, and Crude Oil

(Melabur Di Tengah Kegawatan: Peluang Kepelbagaian dalam Indeks Saham Islam, Bitcoin, Emas dan Minyak Mentah)

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ABSTRACT

This study investigates diversification potential in the Malaysian and United States (US) Islamic stock indices, Bitcoin, gold, and crude oil prices, particularly amidst economic crises. It uses wavelet coherence and MGARCH-DCC on a dataset spanning 2014 to 2022. The findings revealed that there are diversification potentials for investors. The dynamic conditional correlation (DCC) analysis indicated that the correlation of gold with both indices is generally low, except for a brief period of heightened correlation during the COVID-19 pandemic in 2020. The correlations between bitcoin and Islamic Stock Index Returns (ISIR) of the US and Malaysia respectively are generally weak across the study period except during the pandemic for the US. Hence, it is prudent for investors with exposure to the countries' stock index to incorporate gold within their portfolio to harness diversification benefits. The results further suggested that Bitcoin is also an appealing option for portfolio diversification. Our findings further revealed that during the Russia-Ukraine conflict, crude oil had demonstrated a minimal correlation with both the US and Malaysia ISIR, providing an opportunity for diversification. The results further suggested that Islamic equities can be a buffer against risk and instability, especially during turmoil, offering crucial implications for Shari'ah-compliant investors in Malaysia and the US. The study points to the need for further investigations incorporating additional economic shocks to understand diversification opportunities across varying investment horizons and holding durations.

Keywords: Portfolio diversification benefits; Bitcoin; Islamic Stock Index Returns (ISIR); wavelet; MGARCH-DCC.

ABSTRAK

Makalah ini mengkaji potensi kepelbagaian dalam indeks saham Islam Malaysia dan Amerika Syarikat (AS), Bitcoin, emas dan harga minyak mentah, terutamanya semasa krisis ekonomi dengan menggunakan kaedah wavelet coherence dan MGARCH-DCC terhadap set data dalam tempoh tujuh tahun (2014-2022). Kajian ini menerangkan prospek kepelbagaian bagi pelabur dan menunjukkan bahawa indeks Malaysia yang mempunyai turun naik yang rendah dan korelasi yang lemah dengan harga emas dapat menggambarkan suasana ekonomi yang stabil dan peluang kepelbagaian. Analisis korelasi bersyarat dinamik menunjukkan potensi Bitcoin sebagai alat kepelbagaian, walaupun mempunyai tahap ketidaktentuan yang tinggi. Emas yang mempunyai korelasi yang rendah dengan indeks dan peranan sejarah sebagai instrumen lindung nilai, telah muncul sebagai pilihan unggul untuk pelabur. Penemuan kajian juga mendedahkan bahawa semasa pergolakan ekonomi yang berpunca daripada konflik Rusia-Ukraine, korelasi antara minyak mentah dan indeks menjadi minimum untuk tempoh kurang daripada 128 hari, mencadangkan potensi kepelbagaian. Keputusan kajian juga menggariskan bahawa ekuiti Islam tidak selalunya menampan terhadap risiko dan ketidakstabilan, terutamanya semasa kegawatan, menawarkan implikasi penting bagi pelabur patuh Syariah di Malaysia dan AS. Kajian ini menunjukkan keperluan untuk menjalankan penyelidikan lanjutan yang menggabungkan kejutan ekonomi tambahan untuk memahami peluang kepelbagaian merentasi pelbagai ufuk pelaburan dan tempoh pegangan.

INTRODUCTION

The contemporary global economy has in recent times faced a plethora of crises that has swept across regions and sectors with profound impacts. Unprecedented events, such as the Gulf War, the Asian financial crisis, a surge in oil prices, the global financial crisis, the European sovereign debt crisis, an oil supply surplus, the COVID-19 pandemic, and most recently, the Russia-Ukraine conflict, have created disruptions across industries. These disturbances have precipitated unemployment, diminished production, and curtailed tourism, among other ramifications (Sun & Wang, 2021; Guan et al., 2021). The intricate interconnections of global financial markets have further heightened the potential for risk transmission and spillover, particularly during periods of uncertainty (Umar & Gubareva, 2021).

Amidst these crises, the industrial sector has faced severe ramifications, following lockdown restrictions during the COVID-19 pandemic engendering a decrease in output and subsequent diminished demand for natural resources. This has introduced volatility and disruption into supply and demand chains associated with resources such as crude oil, coal, and gold. The ongoing conflict between Russia and Ukraine, given Russia's critical position in global energy markets and the substantial weight of its economy, further exacerbates the volatility in natural resource prices that augment potential impacts on global commodities and financial markets.

In this bewildering economic landscape, our research pivots towards Islamic stocks, seeking to discern their unique characteristics and behaviour under these conditions. Historically, conventional finance markets have been punctuated by volatility (Hoque et. al 2016) and have shown a disconnect from tangible economic activities (Igan & Peria, 2020), creating a nebulous climate for investment. In contrast, Islamic finance offers an intriguing alternative, ostensibly mitigating market volatility and aligning returns more closely with the real economy's growth and net profit rate. Islamic finance's core principles, rooted in risk-sharing and tangible economic activity, are designed to insulate against speculation and bankruptcy (Krichene, 2012). The Shariah screening process further differentiates Islamic equities markets from their conventional counterparts (McGowan & Muhammad, 2010; Dewandaru et al., 2014), apparently rendering Islamic stocks less susceptible to shocks due to their lower leverage impact (Dewandaru et al., 2014). Thus, it is of paramount importance to scrutinise the relationship between commodities and Islamic stock markets, particularly in the context of the volatility and correlation during the COVID-19 pandemic and the Russia-Ukraine war.

Simultaneously, cryptocurrencies, a relatively recent entrant in the financial landscape since their debut in 2009, have stirred considerable debate as potential hedges against traditional assets. With the growing uncertainty and investment risks in the wake of recent crises, investors are eyeing alternative financial assets like Bitcoin, considering their potential for risk mitigation and portfolio diversification. This shift is partly a response to gold's diminishing capacity as a reliable safe haven in the post-global financial crisis era (Chkili et al., 2021). This study seeks to contribute to the extant academic discourse on this issue by examining the potential of these alternative assets as diversification tools. The doctrine of diversification, a cornerstone of investment strategy, advocates for a diversified portfolio of assets to mitigate risk exposure. Investors are perpetually in pursuit of uncorrelated assets that can offer superior diversification benefits.

The objective of this study is to explore the potential for diversification among the Islamic stock indices of Malaysia and the United States (US), Bitcoin, gold, and crude oil prices, especially during pronounced economic disturbances. Our study explored the implications of diversification for investors exposed to Malaysian and US Islamic stock indices and scrutinised the volatilities and correlations of selected variables during the pandemic and conflict periods. We utilised the MGARCH-DCC and wavelet approaches to explore potential portfolio diversification benefits. Our focus was on investigating the time-varying volatilities and correlations between the Malaysian and US Islamic stock indices. Additionally, we analysed time-scale-dependent fluctuations and correlations with selected commodities, namely Bitcoin, gold, and crude oil. The findings show that Malaysia's ISIR has minimal volatility, indicating a solid and steady economic base. Given its low correlation with the Islamic indices of Malaysia and the US and its well-established reputation as a vital hedging tool, gold emerges as a preferable choice for investors in the US and Malaysia ISIR compared to Bitcoin.

Recognising the scarcity of research on emerging economies such as Malaysia, our study offered a multi-faceted contribution to the extant literature. This study provided substantial implications for various stakeholders who can leverage our findings practically. For investors, our research furnished detailed insights into the nuances of diversification during periods of crisis, which offered a valuable roadmap for asset allocation within portfolios. Specifically, those looking to venture into emerging markets, such as Malaysia, or alternative assets, like Bitcoin, can draw substantial guidance from our research to inform their decisions. For policymakers and regulators, our work elucidated how different asset classes react to global shocks, thus informing the development of robust

financial regulation and crisis management policies. Financial advisors and analysts may also leverage our study to guide their clientele effectively, particularly those considering portfolio diversification in turbulent times. Moreover, we contribute to the existing financial literature by not only examining under-explored markets and emergent assets like cryptocurrencies but also by bridging the understanding of crisis dynamics with strategic portfolio diversification. Tran (2022) conducted a comprehensive study focusing on the relationship between financial market volatility and real economic events, using VNIndex's two-decade daily stock data. However, the study did not delve deeply into asset volatilities and their interrelationships. The innovative methodologies we employed, such as the MGARCH-DCC and wavelet techniques, offer nuanced insights into asset volatilities and correlations, contributing a new dimension to financial research methodologies. In contrast, Tran (2022) use GARCH family models and distribution rules.. Our research also diverged from Tran's (2022) in that we concentrated on the Islamic indices in both developed and emerging markets, such as the US and Malaysia. Additionally, we examined the commodities market, which is strongly connected to stock indices because of the financialisation occurring within the market.

The structure of this paper is designed for logical progression and clarity. Section two encapsulates the relevant previous studies on gold, Bitcoin, portfolio diversification, and stock market indices and delves into the theoretical underpinnings essential for this research. Section three provides a detailed exposition of the methodologies employed to achieve the objectives of the study. Section four engages in a meticulous analysis of the data and presents the results. Section five synthesises the results of the analyses, offering cogent interpretations and explanations.

LITERATURE REVIEW

In the seminal work of Markowitz (1959), a pioneering hypothesis known as the Portfolio Diversification Theory was posited. Additionally, Markowitz conceived the Modern Portfolio Theory (MPT), advocating that a meticulously constructed portfolio of assets with low correlated returns should theoretically yield less volatility than the individual securities' aggregated, weighted average volatilities. However, initial iterations of MPT assumed a standard distribution of portfolio variances, a supposition that Markowitz later contested, citing its inadequacy in comprehensively capturing risk. Subsequent refinements have been proposed to align the model more closely with real-world asset return distributions, addressing asymmetries and leptokurtic 'fat tails.' This study adopted the MGARCH-DCC approach, which accommodates Student's t-distribution, thus providing a better fit for fat-tailed distributions of

index returns (Pesaran & Pesaran, 2010). Concurrently, the wavelet transform approach mitigates the need for any distributional assumptions, leading to a more realistic representation of market realities (In & Kim, 2013).

By the end of March 2020, the COVID-19 pandemic had induced partial or total lockdowns in over 100 countries, with vehicular traffic in major global cities plummeting by 70%-90%, impacting billions of individuals globally (Dunford et al., 2020). Governments worldwide deployed unprecedented measures to contain the outbreak and cushion the economic fallout, investing heavily in testing, quarantining, and treatment strategies, while concurrently rolling out stimulus packages (Ashraf, 2020).

Guven et al. (2022) empirically investigated how daily mortality rates, case increases, and government responses influenced stock markets in 21 emerging economies. Their findings underscored that daily upticks in fatalities and cases undermine stock market returns, implying a need for sustained government intervention to maintain investor confidence. Harjoto et al. (2021) examined the impact of the COVID-19 pandemic on stock market risk and return across 76 emerging and developed countries. Interestingly, they found daily COVID-19 cases, rather than deaths, to be strongly correlated with daily stock excess returns, highlighting the potential for portfolio diversification by investing in both emerging and developed equity markets amidst the pandemic.

The role of cryptocurrency, particularly Bitcoin, in enhancing portfolio diversification is yet to be comprehensively examined. This digital asset, which has seen unparalleled growth in recent years, has been scrutinised for its potential role as a hedge, safe haven, or diversifier. Bouri et al. (2017) identified Bitcoin's potential in portfolio diversification, but found it lacking as a hedging tool, echoing Yermack's (2015) assertion that Bitcoin is better suited as an investment asset rather than a currency. However, Hanley (2013) presented a contrary view, contending that Bitcoin's price variations are largely independent of daily macroeconomic fluctuations, and that the digital asset's volatility remains largely speculative and cannot be effectively hedged.

Bhuiyan et al. (2023) explored the diversification potential of Bitcoin compared to traditional assets like gold under different market conditions using wavelet analysis and multivariate GARCH models. Their study, which spanned from January 2014 to May 2022, found Bitcoin consistently offered diversification opportunities across several market indices, particularly under normal conditions. However, during crisis periods such as the COVID-19 pandemic and the Russia-Ukraine conflict, the diversification benefits of Bitcoin and gold were conditional, emphasising the need for awareness of geopolitical influences when assessing these assets' diversification capabilities. This study contributed to the understanding of Bitcoin as a portfolio management tool, highlighting the necessity of considering market conditions in this context.

Given the scarcity and conflicting nature of research on commodities and Bitcoin for portfolio diversification strategies, this study aims to provide a further empirical examination, offering valuable insights into optimal portfolio allocation amidst times of global financial turbulence and heightened market uncertainty. Simultaneously, the role of commodities in portfolio diversification has been dramatically redefined by the 'financialisation' of commodity markets, a process that has seen traditional players like refineries, mines, and farmers replaced by hedge funds, mutual funds, and institutional investors. This influx of capital from financial market participants has intensified the correlation between commodity and stock indices, necessitating the discovery of new investment products to maintain risk-return equilibrium in investment portfolios (Domanski & Heath, 2007).

Islamic capital markets have demonstrated resilience in the face of global financial crises, outperforming conventional investments during such periods of systemic disruption (Masih et al., 2018). This can be attributed to the unique characteristics of Islamic finance, which emphasises risk-sharing and stringent screening of investment opportunities based on ethical and financial criteria. These factors suggest that Islamic capital markets could offer an alternative avenue for portfolio diversification.

While considerable research has been conducted to understand the impact of geopolitical crises on global financial markets and the role of traditional assets in portfolio diversification, there is a clear gap in the existing literature when it comes to the intersection of alternative financial instruments such as cryptocurrencies and Islamic equities, especially in the context of crises like the COVID-19 pandemic and the Russia-Ukraine war. Previous research, such as that conducted by Bouri et al. (2017), had made initial explorations into the potential of Bitcoin as an investment asset but fell short of an in-depth investigation into its role as a diversification tool, particularly during periods of economic turbulence. Compared with past research such as Bhuiyan et al. (2023), this study presented a distinct perspective by focusing on the diversification potential of the Malaysian and US Islamic stock indices, Bitcoin, gold, and crude oil prices. While the research methodologies shared with the earlier works included wavelet coherence and MGARCH-DCC, the assets analysed in this study provided specific insights for investors, particularly those adhering to Shariah principles. Furthermore, the role of Islamic indices, which had shown resilience during systemic disruptions (Masih et al., 2018), had not been thoroughly evaluated in conjunction with commodities and cryptocurrencies, leaving a gap in our understanding of how these asset classes may interact in a diversified portfolio. Tran (2022) conducted a comprehensive study focusing on the relationship between financial market volatility and real economic events, using VNIndex's two-decade daily stock data. Through various GARCH

family models and distribution rules, EGARCH with a Student-t distribution was identified as the most apt for depicting the volatilities of logarithmic returns. Our study aims to fill these knowledge gaps, providing a detailed empirical examination of alternative assets in the context of a volatile global financial landscape. We also address the dearth of research focusing on emerging economies such as Malaysia, offering insights beyond the usual focus on developed countries. In doing so, our research will contribute to a broader and more nuanced understanding of portfolio diversification strategies, beneficial for both scholarly discourse and investors seeking to navigate turbulent markets.

METHODOLOGY

DATA

The information gathered encompasses daily valuations of Bitcoin, crude oil, and gold, in addition to indices from the Morgan Stanley Capital International (MSCI) for the US (specifically, the MSCI United States Islamic Net Index), as well as the FTSE Bursa Malaysia EMAS Shariah Index. It is noteworthy that Bitcoin's price is defined in relation to its exchange rate with the US dollar. Our data were sourced from Thomson Reuters DataStream, a trusted provider of financial and economic information, thus ensuring its reliability and integrity. This dataset spans a time frame, from August 4, 2014, to April 29, 2022. The extended study period serves a critical purpose. This period captures significant global events that have extensively influenced economic and financial landscapes. The chosen timeline allows us to consider the performance and volatility of Islamic stock indices during periods of global economic stability, as well as periods marked by financial crises, such as the COVID-19 pandemic and the Russia-Ukraine conflict. The span allows us to assess the robustness and resilience of these indices under different economic conditions. Moreover, it marks a significant growth phase of cryptocurrencies, enabling us to analyse the potential of these emergent assets as diversification tools. Therefore, the selected time frame provides a rich backdrop against which the data can be examined and aligned with our research objectives to gain insights into crisis dynamics and strategic portfolio diversification.

Our research focuses on the Islamic stock indices of Malaysia and the US, a selection anchored in strategic justification. These two nations represent a crucial juxtaposition between an emerging economy and an established financial powerhouse, thereby providing a broad spectrum for comparative analysis. Malaysia is a leading global player in Islamic finance, renowned for its well-developed Islamic banking and financial infrastructure. The US, on the other hand, albeit not an Islamic country, offers a unique perspective as it houses a diverse market with an evolving landscape of

Islamic finance. This comparison enables us to examine the behaviour of Islamic stocks in different economic, cultural, and regulatory settings. It fosters a comprehensive understanding of the dynamics of Islamic finance in both emerging and developed markets and promotes wider applicability of the research outcomes. Thus, the selection of Malaysian and US Islamic stock indices aligns perfectly with our study's objectives, bolstering its scope and relevance in the existing literature.

MULTIVARIATE GARCH – DYNAMIC CONDITIONAL CORRELATION

This study employed a rigorous and systematic approach, utilising the Multivariate Generalized Autoregressive Conditional Heteroskedasticity model, known colloquially as the Multivariate GARCH (MGARCH) model, with a specific focus on its Dynamic Conditional Correlation (DCC) variant. To unpack the essence of the DCC MGARCH model, it is imperative to first understand the basic premise of the GARCH model. The GARCH model, proposed by Bollerslev (1986), is an extension of the Autoregressive Conditional Heteroskedasticity (ARCH) model put forth by Engle (1982). These models are designed to handle the volatility clustering that is often observed in financial time series data, where periods of high volatility tend to be followed by more such periods, and the same holds true for periods of low volatility. The MGARCH model is a natural extension of this, designed to handle multiple time series simultaneously, capturing not only the individual volatilities of each series but also the covariances between them. This makes it particularly useful for our research, as we are dealing with multiple financial assets: Bitcoin, crude oil, gold, and two different stock indexes.

The DCC variant of the MGARCH model, introduced by Engle (2002), was particularly suited to our study. The main feature of the DCC model was that it allowed the correlation structure between the different time series to change over time, a crucial feature given the dynamic nature of financial markets. To operationalise this, we first fitted a univariate GARCH model to each of the series to model their individual volatilities. Next, the residuals from these models, which were assumed to follow a multivariate normal distribution, were subsequently used to model the dynamic correlations between the series. Our data will be analysed using this DCC MGARCH model proposed by Pesaran and Pesaran (2010) to achieve the first study objective, providing us with valuable insights into the dynamics of these financial assets and their interrelationships. This robust methodology will allow us to capture the nuances of our dataset, thereby providing a comprehensive understanding of the interplay between these diverse financial assets over the study period. Normal and t-distributions are used to create the most efficient output. The MGARCH analysis necessitates the computation of conditional cross-asset correlations using DCC-MGARCH using the following formulation;

$$\tilde{\rho}_{ij,t-1}(\phi) = \frac{q_{ij,t-1}}{\sqrt{q_{ii,t-1}q_{jj,t-1}}} \tag{1}$$

Where $q_{ij,t-1}$ are given by

$$q_{ij,t-1} = \bar{\rho}_{ij}(1 - \phi_1 - \phi_2) + \phi_1 q_{ij,t-2} + \phi_2 \tilde{r}_{i,t-1}\tilde{r}_{j,t-1} \tag{2}$$

In the above equation, $\bar{\rho}_{ij}$ stands for the (i,j) th unconditional correlation, ϕ_1 and ϕ_2 represent the parameters with the condition of $\phi_1 + \phi_2 < 1$, and $\tilde{r}_{i,t-1}$ denotes the standardised asset returns. The study estimates $(1 - \lambda_{i1} - \lambda_{i2})$ to evaluate the nature of the mean reversion process. Several validation tests will be carried out in order to validate our models for robustness tests. More details on the MGARCH model may be found in Pesaran and Pesaran (2010).

CONTINUOUS WAVELET TRANSFORMATION (CWT)

Our second study objective may be met by using a continuous wavelet transform (CWT), an exceptionally robust tool in the time-frequency analysis of non-stationary signals, such as financial time series data. To comprehend the CWT, it is first necessary to understand the concept of a wavelet, which is essentially a waveform of effectively limited duration that has an average value of zero. The word "wavelet" means a small wave so-called, since their functions are integrated over to zero and they oscillate and localised, or limited in duration. The 'continuous' part of the CWT refers to the fact that the transformation is calculated for every possible scale and position of the wavelet, creating a detailed view of how the frequency content of the signal changes over time. This provides a two-dimensional view of the signal, with one dimension representing time and the other representing frequency (or scale in wavelet terminology), thus capturing both localised frequency behaviour and temporal behaviour.

The CWT facilitates a detailed decomposition of the data into several frequency bands, spanning a broad range of time horizons. As expounded by Haque et al. (2018), the CWT's ability to function across time and frequency domains allows it to adeptly capture heterogeneity over diverse investment durations. The mathematical calculation of CWT, denoted as $W_X(u,s)$, involves the projection of a chosen mother wavelet, symbolised as ψ, onto the time series under examination, $x(t) \in I^2(R)$. This process follows the succeeding equation:

$$W_X(u, s) = \infty_{-\infty} x(t) \frac{1}{\sqrt{s}} \psi\left(\frac{t-u}{s}\right) dt \tag{3}$$

Within this framework, 'u' indicates the temporal domain, whereas 's' refers to the frequency domain. The wavelet coherence equation, (Torrence and Webster, 1999) is employed in the dual time series:

$$R\frac{2}{n}(s) = \frac{IS\,(s^{-1}W\frac{xy}{n}(s))I^2}{S(S^{-1}IW\frac{x}{n}(S))I^2 S(S^{-1}IW\frac{y}{n}(S))I^2} \qquad (4)$$

In this scenario, 'S' refers to a smoothing operator, while 's' designates the wavelet scale. 'WWn^x(S)' corresponds to the continuous wavelet transformation of the time series X, and 'Wn^y(S)' typifies the continuous wavelet transform of the time series Y. 'Yn^{xy} (s)' relates to a cross wavelet transform of the dual time series X and Y, given in In and Kim (2013). This research employs the wavelet phase difference methodology, as delineated by Bloomfield et al. (2004), to explore the degree of interdependence and the order of influence between oil price and stock prices in the BRICS nations. The phase disparity between m(t) and n(t) is represented as follows:

$$\emptyset_{mn} = \tan^1(\frac{\Im\{S(s^{-1}W_{mn}(u,s))\}}{\Re\{S(s^{-1}W_{mn}(u,s))}) \qquad (5)$$

$(xi)\,with\,\emptyset_{mn} \in [-\pi, \pi]$

In our research, the CWT will be utilised to analyse the financial time series data of Bitcoin, crude oil, gold, and two Islamic stock indices. By applying the CWT, we can examine how the frequency content of these series changes over time, thereby gaining insights into their dynamic behaviour. This is particularly pertinent given the volatile nature of these financial assets and the non-stationary nature of their time series data. This methodological approach will offer us an understanding of our dataset, enabling us to unravel the intricate dynamics underpinning these various financial assets during our chosen period of study. Few studies, such as Abdullah and Masih (2016), have employed the CWT in economics and finance research. In the CWT approach, the number of wavelets need no specification thus providing a competitive advantage over the DWT/MODWT methods. The CWT maps two-dimensional representations of series correlations, enabling users to readily recognise and determine patterns or hidden information.

This study employs the least asymmetric wavelet filter of length L=8 and represented as LA(8) (Daubechies, 1992). The wavelet filter produces eight coefficients. Based on previous studies, LA(8) is sufficient to cater for time series data (Gençay et al., 2001; In & Kim, 2013). Further, LA(8) offers a smoother wavelet coefficient than other classes of wavelet filters such as Haar filter (Gencay et al., 2001; In and Kim, 2013).

EMPIRICAL FINDINGS AND INTERPRETATIONS

DESCRIPTIVE OF DATA

Figure 1 presents the raw chronological sequences of all selected variables. This visual representation elucidates the pronounced volatility of Bitcoin's price, characterised by rapid and significant price fluctuations, particularly evident in the period spanning 2017 to 2022. An upward trajectory is discernible in the prices of both oil (commencing in May 2020) and gold (beginning in June 2018), indicative of an augmented demand for these commodities, potentially precipitated by global economic uncertainties.

In the face of significant global crises, such as the COVID-19 pandemic and the Russia-Ukraine conflict, the US Islamic index has displayed a resilient and ascending trend from May 2020 onwards. This suggests that these global events have exerted minimal disruptive influence on the US Islamic index, underscoring the resilience and robustness of this particular financial measure.

In contrast, the FTSE Bursa Malaysia EMAS Shariah Index exhibits a more tumultuous trajectory, marked by a precipitous decline in May 2020. This suggests that the index, and by extension the broader Malaysian economy, was significantly impacted by the COVID-19 pandemic. The vulnerability of Malaysia's Islamic stock index may be attributed to the country's relatively smaller and more fragile economic structure, especially when juxtaposed with the substantial economic clout of the US, widely regarded as a pivotal hub of global economic activity and growth.
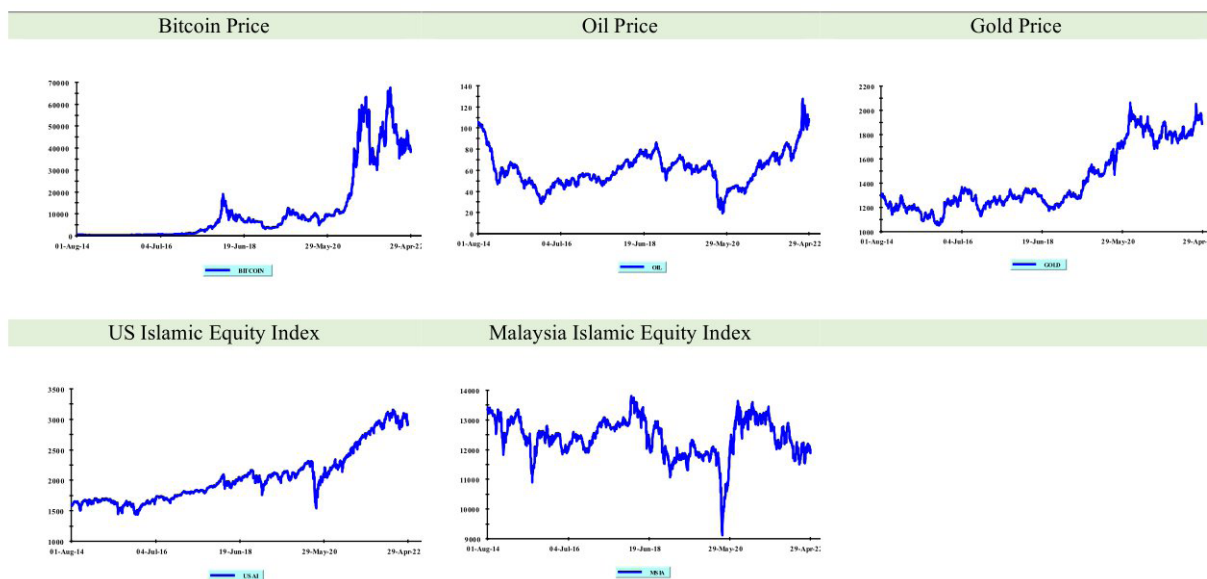
Bitcoin Price	Oil Price	Gold Price

US Islamic Equity Index	Malaysia Islamic Equity Index

FIGURE 1. Dynamics of Raw Time-Series Data

TABLE 1. Descriptive statistics

Variable	Mean	Standard Deviation	Min	Max	Skewness	Kurtosis	Number of observations
BITCOIN	0.0022	0.048	-0.333	0.273	-0.591	7.033	1898
OIL	0.0000	0.027	-0.280	0.191	-1.016	16.063	1898
GOLD	0.0002	0.009	-0.059	0.047	-0.246	3.384	1898
USA	0.0003	0.011	-0.118	0.087	-0.774	16.921	1898
MSIA	-0.0001	0.007	-0.053	0.058	-0.486	7.137	1898

Note: "BITCOIN" corresponds to the Bitcoin prices return, "OIL" designates the crude oil prices return, and "GOLD" signifies the gold prices return. "USA" refers to the United States' Islamic stock index returns, whereas "MSIA" represents Malaysia's Islamic stock index returns.

Table 1 provides a comprehensive statistical overview of the returns series, which are calculated through employing the formula $r_t = \ln(P_t/P_{t-1})$, where r_t denotes the series return derived from the natural logarithm, and P_t represents the price index at a specific time 't'. An observation of notable significance is that the average return of Bitcoin noticeably exceeds those of both the stock indices and other commodities under examination.

Moreover, Bitcoin exhibits a markedly pronounced level of volatility relative to crude oil, gold, and stock indices. This amplified volatility can be ascribed to the inherent characteristics of cryptocurrencies, compounded by market sentiment and the behavioural dynamics of investors.

Therefore, from a risk-return perspective, Bitcoin may present a more attractive investment opportunity compared to the stock indices and other commodities examined in this study. However, it is of paramount importance that prospective investors undertake a thorough evaluation of the associated risks in tandem with their individual risk tolerance before embarking on such investment ventures. This will ensure a balanced and well-informed investment strategy, aligning potential returns with acceptable risk levels.

TABLE 2. Pearson Correlation Matrix

	BITCOIN	OIL	GOLD	USA	MSIA
BITCOIN	1				
OIL	0.017	1			
GOLD	-0.006	0.065**	1		
USA	-0.02	0.373**	-0.00006	1	
MSIA	0.118**	0.133**	0.015	0.172**	1

**. Correlation is significant at the 0.01 level (2-tailed).
Note: "BITCOIN" corresponds to the Bitcoin prices return, "OIL" designates the crude oil prices return, and "GOLD" signifies the gold prices return. "USA" refers to the United States' Islamic stock index returns, whereas "MSIA" represents Malaysia's Islamic stock index returns.

Table 2 delineates the Pearson correlation matrix for the variables in focus, offering a detailed exploration of their interrelatedness. The most salient correlation coefficient, at 37%, manifests between the US Islamic stock index and crude oil prices. This correlation underscores a potent connection between these two variables, likely driven by the considerable reliance of the US economy on oil as a primary energy source.

The second highest correlation emerges between the US and Malaysia Islamic stock indices, suggesting limited avenues for diversification between these two indices. This outcome intimates that analogous global phenomena or regional economic trends may influence these markets. The variables exhibit relatively weak correlations on a broader scale, indicating a substantial potential for portfolio diversification. A strategically diversified portfolio can assist investors in mitigating risks and enhancing returns by dispersing investments across a spectrum of asset classes exhibiting low intercorrelations. However, it is critical to acknowledge that correlation should not be the sole criterion informing investment decisions. To ensure a comprehensive and informed investment strategy, investors must also consider a panoply of other factors, such as prevailing market conditions, individual risk tolerance, and specific investment objectives.

FINDINGS AND INTERPRETATIONS OF MGARCH-DCC

In this study, we employ the MGARCH-DCC methodology to meticulously examine the diversification effects of the selected variables. Table 3 provides a detailed account of the maximum likelihood estimates for λ_{i1} and λ_{i2}, corresponding to the returns of commodities and stock indices, respectively. Additionally, the values for of δ_1 and δ_2 represent the comparative values between a multivariate normal distribution and a multivariate Student-t distribution.

The highest log-likelihood value associated with the Student-t distribution stands at 27542, slightly exceeding the corresponding value of 27147 derived under the assumption of a normal distribution. The inferred degree of freedom for the t-distribution is determined to be 6.7454, a figure well below the conventional threshold of 30. This result lends credence to the superiority of the t-distribution over the normal distribution in accurately capturing the leptokurtic nature of the price returns distribution, commonly referred to as 'fat tails'. Given this discovery, the subsequent analysis will be predicated on the multivariate t-distribution framework.

TABLE 3. Estimates of λ_{i1} and λ_{i2}, and δ_1 and δ_2, for the Six Variables under Review

		Multivariate Normal Distribution		Multivariate *t* Distribution	
		Estimate	T-Ratio	Estimate	T-Ratio
Lamda 1 (λ1)	Bitcoin	0.836	40.930	0.861	41.145
	Gold	0.912	39.956	0.943	65.633
	USA	0.762	30.680	0.819	34.653
	Oil	0.854	55.497	0.885	60.995
	Msia	0.891	56.209	0.914	56.124
Lamda 2 (λ2)	Bitcoin	0.103	8.859	0.109	7.597
	Gold	0.054	4.915	0.041	4.868
	USA	0.175	10.197	0.140	8.277
	Oil	0.108	10.149	0.087	8.430
	Msia	0.088	7.608	0.067	5.809
Delta 1 (δ1)		0.947	39.657	0.972	74.850
Delta 2 (δ2)		0.013	3.704	0.009	3.389
Maximised log-likelihood		27147		27541	
Degree of freedom (df)		-		6.745	

Note: and are decay factors for variance and covariance, respectively. "BITCOIN" corresponds to the Bitcoin prices return, "OIL" designates the crude oil prices return, and "GOLD" signifies the gold prices return. "USA" refers to the United States' Islamic stock index returns, whereas "MSIA" represents Malaysia's Islamic stock index returns.

Table 4 showcases the calculated unconditional volatilities and correlations for the quintet of variables under scrutiny. The components positioned diagonally represent the unconditional volatilities, with figures in parentheses denoting the ranking of volatilities, from highest to lowest. Conversely, the off-diagonal constituents stand for the unconditional correlations.

As gleaned from the analysis of unconditional volatility, Bitcoin and crude oil prices appear to attract a significant share of speculative activity, underscored by the substantial volatility in their price returns. This observation is clearly manifested in Table 4, where these two variables exhibit the highest and second-highest volatilities, respectively.

In stark contrast, the Malaysia Islamic index displays the lowest level of volatility. This result signifies Malaysia's relatively stable economic environment and resilient capital market. Gold registers the second-lowest volatility, positioning it as a comparatively more stable commodity than others included in this analysis.

TABLE 4. Estimated unconditional volatility matrix for US and Malaysia Islamic stock indices return and other variables

	BITCOIN		GOLD		USA		OIL		MSIA	
BITCOIN	0.04791	(1)	-0.00490		-0.01845		0.01694		0.11784	
GOLD	-0.00490		0.00898	(4)	0.00157		0.06528		0.01427	
USA	-0.01845		0.00157		0.01128	(3)	0.37323		0.17250	
OIL	0.01694		0.06528		0.37323		0.02685	(2)	0.13351	
MSIA	0.11784		0.01427		0.17250		0.13351		0.00746	(5)

Note: "BITCOIN" corresponds to the Bitcoin prices return, "OIL" designates the crude oil prices return, and "GOLD" signifies the gold prices return. "USA" refers to the United States' Islamic stock index returns, whereas "MSIA" represents Malaysia's Islamic stock index returns.

The central aim of this research is to dissect the interrelationships among the variables under scrutiny. A thorough evaluation of the unconditional correlations outlined in Table 5 unveils that the price of gold displays the weakest correlations with all other factors under consideration, thus positioning gold as an outstanding asset for portfolio diversification.

Gold, universally recognised as a hedging instrument during periods of economic instability, has indeed demonstrated its efficacy as the most potent safe haven among the variables assessed in the face of global events such as the COVID-19 pandemic and the Russia-Ukraine crisis. Bitcoin, manifesting the second-weakest correlation with the other variables, suggests its potential utility as a diversification tool. However, investors contemplating the integration of Bitcoin into their portfolios should proceed with caution, bearing in mind its inherent price volatility.

For investors with holdings in the US and Malaysia Islamic stock indices, diversifying their portfolios with gold is paramount. Given its relative stability and the minimal correlation it exhibits with both Islamic indices, gold emerges as an optimal choice. Table 5 delineates the relative correlations of all prices in a ranking order from the highest to the lowest.

The ordinal information encapsulated in Table 5 discloses two pivotal insights. First and foremost, gold exhibits the weakest association with all other variables. This discovery intimates that the inclusion of gold in portfolio allocation is strongly recommended to optimise a fund's value. Furthermore, as delineated in Table 4, the return on gold price manifests the second-lowest volatility, thereby enhancing its appeal as a diversification instrument. Consequently, given its negligible correlation with virtually all the variables under scrutiny, we postulate that gold emerges as an indispensable financial asset for diversification. Prior scholarly work, such as that by Worthington & Pahlavani (2007), has also indicated that gold acts as a near-perfect inflation hedge, implying its suitability for long-term investment predicated on historical data. In periods of uncertainty, such as during the COVID-19 pandemic and the Russia-Ukraine crisis, gold has proven its mettle as the most trustworthy safe haven.

Secondly, as per the evidence presented in Table 5, Bitcoin displays the second-weakest correlation with the remaining variables under examination. Hence, any investor with stakes in the Islamic indices of the United States and Malaysia, aiming to maximise diversification benefits, should seriously consider incorporating Bitcoin into their portfolio. However, it is crucial to bear in mind that, as illustrated in Table 4, Bitcoin is characterised by high volatility, which may occasionally present complications for portfolio management. Bitcoin has been adopted in addition to official currencies by several countries, including Argentina and Venezuela. Therefore, we propose that Bitcoin could emerge as a viable alternative currency in the future, offering investors an additional tool to hedge against other financial assets.

TABLE 5. Ranking of Unconditional Correlations among the US and Malaysia Islamic Stock Indices Return and Other Variables

Bitcoin (BITCOIN)	Gold (GOLD)	USA ISIR (USA)	Crude Oil (OIL)	Msia ISIR (MSIA)
MSIA	OIL	OIL	USA	USA
USA	MSIA	MSIA	MSIA	OIL
OIL	BITCOIN	BITCOIN	GOLD	BITCOIN
GOLD	USA	GOLD	BITCOIN	GOLD

Note: "BITCOIN" corresponds to the Bitcoin prices return, "OIL" designates the crude oil prices return, and "GOLD" signifies the gold prices return. "USA" refers to the United States' Islamic stock index returns, whereas "MSIA" represents Malaysia's Islamic stock index returns and "ISIR" indicates Islamic stock index returns.

While the previous discussion has expounded upon volatilities and correlations on an unconditional basis, such an approach encounters a key limitation; namely, it fails to intuitively capture the expectation that volatility and correlation would remain static over a seven-year period. A more plausible expectation would be the presence of dynamic volatility and correlation, and to account for this, we employed the Dynamic Conditional Correlation (DCC) model in our study. Consequently, it becomes imperative to scrutinise the temporal aspect of volatility. Figure 2 presents the conditional volatilities for all variables under investigation.

The study discerned that the return on Bitcoin price demonstrates the most volatility among the variables. Bitcoin's price return has exhibited erratic and unpredictable behaviour over the seven-year period under review. Consequently, Bitcoin might present a higher risk profile than the other variables under consideration. The pronounced volatility of Bitcoin constrains its efficacy as a tool for portfolio diversification.

As depicted in Figure 2, the Malaysia Islamic index is the least volatile variable in comparison to the others. This finding corroborates our prior expectation that a robust economy would culminate in a stable stock index. Despite Malaysia being a smaller nation with an emerging economy, its Islamic stock market is well-established and ranks among the most advanced globally. The US Islamic index emerges as the second least volatile

variable, indicative of a stable economy and a sturdy capital market. Being the world's largest economy, it is reasonable to anticipate the US Islamic stock market to exhibit stability and vitality. Thus, we can infer that stock indices display lower volatility than commodities, and investors would stand to reap diversification benefits by incorporating the Malaysian and US stock indices into their portfolios.

This study investigated the temporal dynamics of correlation and volatility between Bitcoin price returns and Islamic stock indices of the United States (illustrated in blue) and Malaysia (depicted in red), as visualised in Figure 3. The graphical representation reveals a consistent correlation between Bitcoin and Islamic stock indices over the period 2014 through 2020. Post-2020, however, the financial landscape became markedly more volatile. Intriguingly, the correlation between the Malaysian Islamic Stock Index Return (ISIR) and Bitcoin experienced a surge, indicating a potential constriction in diversification opportunities. In contrast, the correlation between Bitcoin and the US ISIR had ebbed since 2020, bolstering its suitability as an important alternative for portfolio diversification. The implication here is profound. Investors may achieve superior risk-adjusted returns by synergistically allocating their capital between Bitcoin and the US ISIR, rather than the Malaysian Islamic index. Further inspection of Figure 3 reveals a notable negative correlation between the US ISIR and Bitcoin commencing with the onset of the pandemic. This suggests an intriguing possibility: Bitcoin may serve as a strategic hedging tool and a safe haven for investors with exposure to the US ISIR during periods of heightened uncertainty and market turmoil, such as the current pandemic.

The forthcoming analysis will focus on the interplay between crude oil price returns and the ISIR of the United States and Malaysia. As evident in Table 5, the highest degree of correlation is between crude oil price returns and the US ISIR, thereby undermining its effectiveness as a mechanism for portfolio diversification. Figure 4 further elucidates this relationship, revealing a more pronounced correlation between crude oil and the US ISIR as compared to its Malaysian counterpart. This suggests a heightened sensitivity of the US ISIR to fluctuations in oil prices, a consequence of the US economy's deep-seated reliance on oil as a primary energy source.

The period spanning 2014 to June 2020 manifests an escalating trend for both indices against oil prices, suggesting the absence of diversification benefits during this timeframe. However, the advent of the COVID-19 pandemic precipitated a severe decline in the correlation

of these variables, most notably between Malaysian ISIR and crude oil price returns. This decoupling effect is further augmented by geopolitical tensions such as the conflict between Russia and Ukraine. Interestingly, the pronounced reduction in correlation amidst the pandemic offers a window of opportunity for portfolio diversification, particularly between the Malaysian ISIR and crude oil. A brief negative correlation observed in April 2022 implies that crude oil could potentially serve as a safe haven asset for investors with exposure to the Malaysian ISIR, further emphasising the intricate dynamics of these financial variables in response to global events and market shocks.

In the sphere of financial analysis, the interplay between gold price returns and US ISIR is particularly noteworthy. As per our empirical findings shown in Table 5, gold price returns exhibit the weakest correlation with US ISIR compared to other variables under consideration. This finding offers crucial strategic insights for investors with portfolios heavily weighted towards gold. For such investors, diversification into US ISIR would prove more advantageous than into Malaysia ISIR due to the higher correlation the latter exhibits with gold. Contrarily however, gold emerges as a suitable diversification tool for investors with significant holdings in US or Malaysia ISIR, given the lower correlation these indices exhibit with the precious metal. This inference aligns with the graphical representation in Figure 5 and the data shown in Table 5, thereby validating the consistency and reliability of our analytical methods.

A closer examination of Figure 5 illustrates that the correlation between gold and US ISIR is weaker than the correlation between gold and Malaysia ISIR. Since the onset of the global pandemic in 2020, gold's correlation with both indices has surged, a trend reflective of investor behaviour during periods of heightened uncertainty, as they congregate to the relative safety of gold. This reinforces gold's reputation as an optimal safe haven instrument, particularly in turbulent times such as the ongoing COVID-19 crisis. A historical analysis of the period from 2014 to 2020 revealed a negative correlation between gold and both US and Malaysia ISIR, implying that gold could have served as an effective hedging instrument against fluctuations in both indices. However, the correlation transitioned to the positive domain post-2020, suggesting that during the period of pandemic and geopolitical tensions, gold failed to serve as an efficient hedging and safe haven instrument for both indices. Investors should heed this finding and accordingly formulate their investment strategies under similar circumstances in the future.
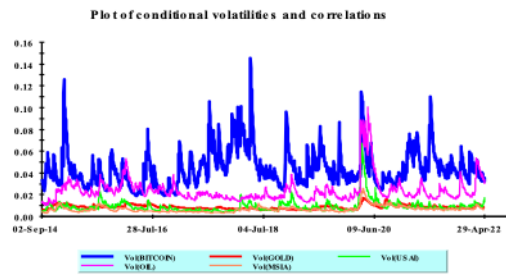
FIGURE 2. Conditional volatilities of US and Malaysia stock indices return and other variables
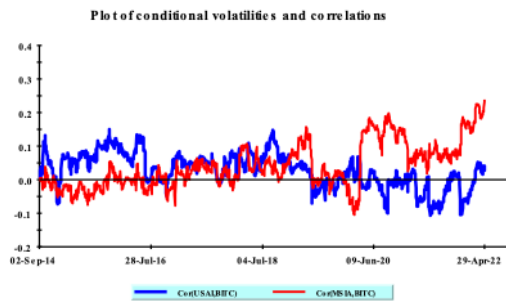

FIGURE 3. Conditional correlation of bitcoin price return with US and Malaysia and islamic indices return
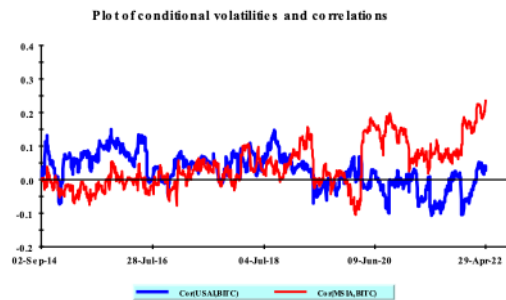

FIGURE 4. Conditional correlation of crude oil price return with the US and Malaysia islamic stock indices return
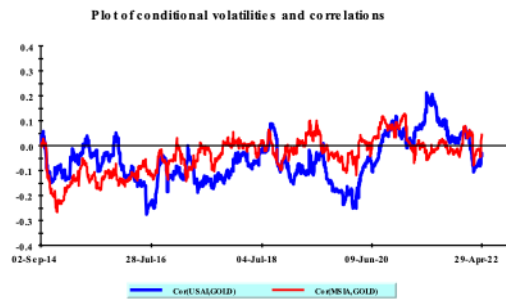

FIGURE 5. Conditional correlation of gold price return with US and Malaysia islamic stock indices return

CORRELATION OF US AND MALAYSIA ISLAMIC
STOCK INDICES WITH OTHER VARIABLES AT
DIFFERENT TIME AND INVESTMENT HORIZONS
BASED ON THE CONTINUOUS WAVELET TRANSFORM

We then proceed with an examination of the Continuous Wavelet Transform, as represented in Figures 6 through 11. These figures elucidate the phase differential across all variables, spanning scales from 1 (encompassing 1-2 days) to 8 (roughly equivalent to two market years or 512 days). The horizontal axis demarcates the trading day period, while the vertical axis signifies the investment interval, with specific dates corresponding to the horizontal axis enumerated in Table 6. The curvilinear boundary shown at the base of the figures is a product of Monte Carlo simulations and denotes the 5% significance level. The colour-coded gradations in the figure provide an intuitive understanding of correlation intensities. A shift towards red signifies high correlation, while a transition towards blue indicates low correlation. This colour scheme is systematically explained in the legend provided on the right side of each figure. Through such innovative visual representations, we aim to facilitate a deeper understanding of the complex interrelationships among the variables under study, thereby equipping financial stakeholders with helpful guides to inform their investment decisions.

The wavelet techniques were used to delve into the correlation between the US and Malaysian indices and other critical variables, thereby elucidating potential avenues for portfolio diversification. As Figure 6 illustrates, an investor with Bitcoin, who also holds investments in the US ISIR, can potentially benefit from diversification over any chosen investment horizon. This is attributed to Bitcoin and the US ISIR showing negligible correlation in both the short and long run. The correlation however surged significantly during the COVID-19 pandemic period in 2020. Similarly, the Malaysian ISIR showed low correlation with Bitcoin, but this became greatly intensified during the pandemic. It should thus be noted that a low correlation between variables may harbour the potential for long-term diversification benefits. While Bitcoin is found to be the second least correlated asset with both the US and Malaysian indices, as demonstrated in Table 5, its substantial volatility, as indicated in Table 4 and Figure 2, curtails its diversification potential when paired with these indices. This suggests that the potential advantages of diversification must be carefully weighed against the inherent volatility of Bitcoin before integrating it into a diversified investment portfolio.

We also similarly examined the correlation between crude oil and the stock indices. Figure 8 emphasizes that to optimally harness diversification benefits, an investor ought to maintain a portfolio of crude oil and US ISIR for a short-term duration, specifically less than a month (1 to 30 days). The correlation between these assets becomes considerably pronounced with extended investment portfolio. Figure 9 shows the parallel evidence with the correlation between crude oil and the Malaysia ISIR which enhanced greatly beyond the 30-day holding period. However, juxtaposing Figures 8 and 9 reveals that the US ISIR exhibits a more robust correlation with crude oil than the Malaysian ISIR does. This observation aligns with the outcomes from Figure 4, which employs the MGARCH-DCC method. The explanation for this divergence could be due to greater number of companies engaged in the crude oil and energy sectors behind the US ISIR, in contrast to the much smaller number supporting the Malaysia ISIR. Consequently, the US and Malaysia ISIR displayed a higher sensitivity to fluctuations in crude oil prices as compared to changes in Bitcoin prices, given both nations' significant reliance on crude oil for their energy requirements and revenue streams.

We further assessed the interplay between the US ISIR and gold. As indicated in Table 5, gold displays the most minimal correlation with the US ISIR, thus presenting a promising portfolio diversification avenue. As per Figure 10, an investor who allocates assets to the US ISIR and gold can reap diversification benefits during specific intervals. These include the short-term duration of fewer than 32 days and the mid-term periods of 128 to 256 days. The correlation between these variables is notably low during these timeframes. Interestingly, the correlation of the US ISIR with gold is markedly weaker when compared to that with Bitcoin and crude oil. This observation is corroborated by the findings presented in Table 5, which utilise the MGARCH-DCC method. Figure 11 unveils the correlation dynamics between the Malaysia ISIR and gold, which bear striking similarities to the correlation patterns of the US ISIR. Subdued correlation can be observed for investment durations in timeframes of less than 30 days and between 128 to 256 days. However, during the COVID-19 outbreak in 2020, a heightened correlation between gold and both indices emerged for holding periods exceeding 256 days. Consequently, investors can still secure diversification benefits during such periods of crisis, provided their investment holding period remains less than 256 days.

In summary, our analysis underscores the potential for investors to harness diversification benefits when investing in gold and stock indices. These benefits are particularly pronounced within specific temporal frames; in the short term (less than 32 days) and mid-terms (between 128 to 256 days). However, extending the holding period beyond these intervals may subject the investor to pronounced correlation risk. In comparison to other commodities under consideration, the correlation between the indices and gold is notably subdued. Therefore, the strategic inclusion of gold within investment portfolios can render substantial benefits, fortifying their resilience and performance in varying market scenarios.

TABLE 6. Date for horizontal axis

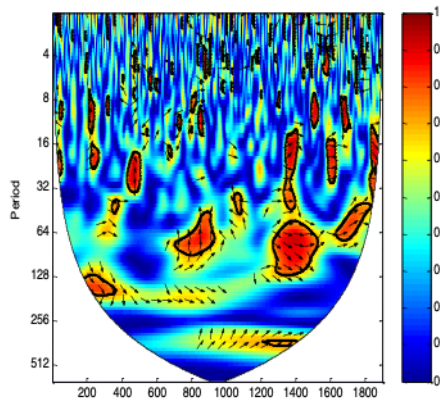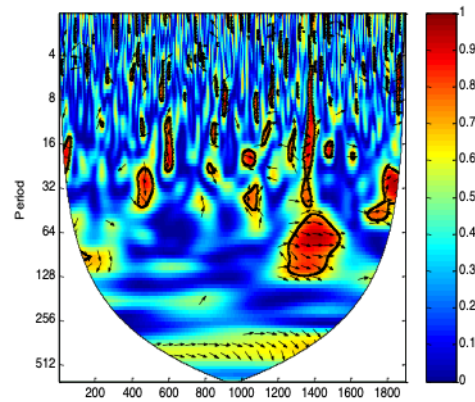| Horizontal Axis	Date
200	May 2015
400	March 2016
600	January 2017
800	November 2017
1000	August 2018
1200	June 2019
1400	April 2020
1600	February 2021
1800	April 2022

FIGURE 6. CWT – Bitcoin PR vs USA ISIR
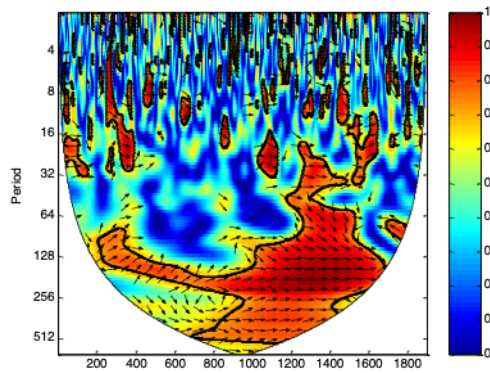

FIGURE 7. CWT – Bitcoin PR vs Malaysia ISIR
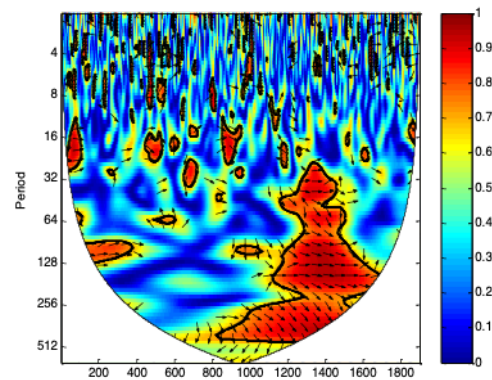

FIGURE 8. CWT–Crude Oil PR vs USA ISIR
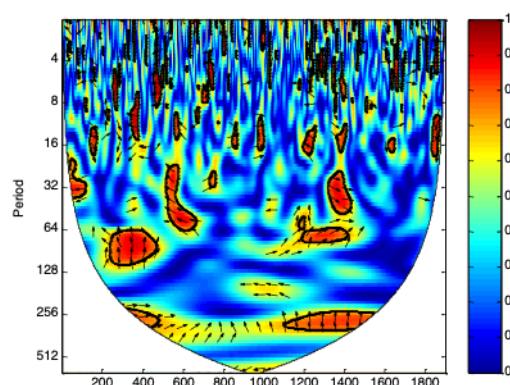

FIGURE 9. CWT–Crude Oil PR vs Malaysia ISIR
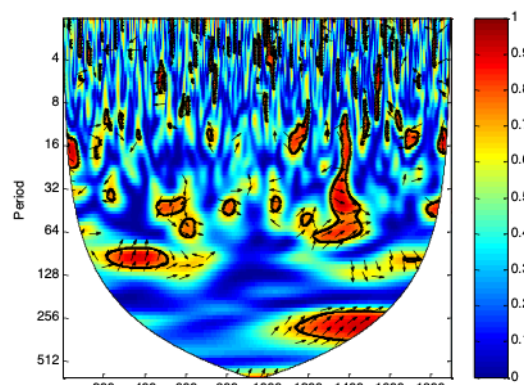
FIGURE 10. CWT – Gold PR vs USA ISIR

FIGURE 11. CWT – Gold PR vs Malaysia ISIR

CONCLUSION

This research examines the diversification possibilities inherent within the Malaysian and US Islamic stock indices, Bitcoin, gold, and crude oil prices, particularly in the face of significant economic shocks. The study accomplishes its objectives by employing methodologies namely wavelet coherence and MGARCH-DCC, on a robust dataset extending from August 2014 to April 2022. We aimed to illuminate diversification opportunities for investors keen on the Malaysian and US Islamic stock indices, while simultaneously navigating exposure in the commodities market during economic crises, such as the COVID-19 pandemic and the Russia-Ukraine conflict. It is essential for investors seeking optimal portfolio diversification to grasp the appropriate Islamic stock indices and commodities for investment, alongside understanding how diversification benefits vary across distinct investment horizons and stockholding durations.

The MGARCH-DCC results position Malaysia's ISIR with the lowest volatility, which suggests a stable and robust economic foundation. Additionally, Malaysia's ISIR exhibits the most tenuous correlation with the price of gold. Hence, it is prudent for investors with exposure to Malaysia's ISIR to incorporate gold within their portfolio to harness diversification benefits. Our dynamic conditional correlation analysis revealed that the US and Malaysia ISIR exhibit the second-lowest correlation with Bitcoin, thus marking it as a promising candidate for diversification within the indices. However, considering Bitcoin's volatility, as illustrated in Table 4 and Figure 2, investors must exercise considerable caution when integrating the currency as a diversification tool in their portfolio. Gold, being the least correlated with the indices and having a recognised history as an essential hedging instrument, is the superior option for investors with exposure to the US and Malaysia ISIR.

The CWT findings reveal opportunities for diversification between Bitcoin and the US ISIR across most holding periods, barring the COVID-19 pandemic. During the pandemic, the correlation between these two variables was notably high for a holding period of 64 to 128 days. However, the correlation between them is generally low across the seven-year study period. A similar low correlation between the Malaysia ISIR and Bitcoin was observed, making Bitcoin an appealing option for portfolio diversification. Crude oil has demonstrated a significant correlation with both the US and Malaysia ISIR, particularly during the COVID-19 pandemic. However, during the Russia-Ukraine conflict, the correlation between the commodity and the indices was minimal for periods of less than 128 days, providing an opportunity for diversification. Drawing from the CWT results and congruent with the MGARCH-DCC findings, gold appears to be the most optimal commodity for diversification for both indices. The correlation of gold with these indices was generally low, except for a brief period of heightened correlation during the pandemic in 2020. Therefore, this study contends that gold offers a sterling diversification tool, with Bitcoin demonstrating potential as an interesting future option. Assuming Bitcoin's volatility can be mitigated, it could serve as an excellent instrument for portfolio diversification, attractive to high-quality investors.

While this study contributes to our understanding of variable correlation and volatility in identifying diversification opportunities across different investment horizons and holding durations, it also underscores that Islamic equities do not invariably serve as a bulwark against risk and instability, particularly during periods of turmoil, a finding that diverges from the conclusions of Kenourgios et al. (2016). These findings carry profound implications for Shari'ah-compliant investors in Malaysia and the US. Understanding the correlations and volatilities of the variables under scrutiny is instrumental in procuring a high-return investment strategy. Additionally, these insights can guide governmental resource allocation and policymaking at various investment horizons. Future extensions of this study might incorporate additional economic shocks, such as the subprime mortgage crisis.

The outcomes of this research hold profound implications for a multitude of stakeholders, including

individual investors, institutional investors, policymakers, and financial advisors. For instance, investors interested in the US and Malaysian Islamic stock indices can leverage our findings to enhance portfolio diversification, thereby potentially maximising returns and mitigating risk during economic downturns. Policymakers can use these insights to formulate strategic decisions about investment horizons, resource allocation, and financial regulations that foster economic stability and growth. Financial advisors can integrate these findings into their practice to provide tailored advice that aligns with client risk tolerance and investment objectives.

Nonetheless, this study is not without its limitations. The focus has primarily been on the Islamic stock indices of the US and Malaysia, and commodities like Bitcoin, gold, and oil, which restrict the scope of diversification analysis. Future research could broaden this perspective by considering a wider range of asset classes and geographic regions. Furthermore, this research has concentrated on specific economic shocks, such as the COVID-19 pandemic and the Russia-Ukraine conflict. Future studies might incorporate analysis of other significant events, like the Global Financial Crisis, to explore their impact on asset correlation and volatility. Lastly, the volatility of Bitcoin was highlighted as a key consideration for investors. Future research should explore mechanisms for mitigating this volatility, potentially positioning Bitcoin as a more viable option for portfolio diversification.

ACKNOWLEDGEMENTS

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